PHARM 702.
Recent Advances in Pharmacology and Toxicology

Course Description: This course comprises reading, informal presentation and discussion of topics in pharmacology, toxicology and related disciplines from the current scientific literature. Critical evaluation of experimental design, data analysis and interpretation are emphasized.

Credit Hours: 1

Course Prerequisites: None

Course Dates: Spring Semester (January 10 – May 13, 2010)

Course Times: Specific Schedule to be arranged

Course Location: G301

Instructor:

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Required Text and Other Learning Resources:

There is no required text. However, it is recommended that the student review the articles listed below.

'*Bringing up scientists in the art of critiquing research*' by Barbara J. Kuyper (from BioScience 1991. 41(4):248-249); appended

'*How to critique a journal article'* by the Center for Teaching and Learning, University of Illinois, Springfield. FIU.edu; Collins; appended

'*How to read a Scientific Research Paper – a four point guide for students and for faculty'* by Ann McNeal, School of Natural Science, Hampshire College, Amherst, M
http://hampshire.edu/~apmNS/design/RESOURCES/HOW_READ.html

'How to Read a Scientific Paper' by John W. Little and Roy Parker, Department of Biochemistry, University of Arizona
http://www.biochem.arizona.edu/classes/bioc568/papers.htm

Course Overview: Recent Advances in Pharmacology and Therapeutics is intended as a forum for casual presentation and discussion of current scientific literature to a relatively friendly audience. Ultimately, it is hoped that the experience gained by participation in this course will better prepare a student for critical evaluation of their own research.

The course consists of a combination of student presentations and group discussions of recent primary articles in the scientific literature.

Group Discussions – For group discussions, there will be no presentation of the paper per se. However, students are expected to read and critically evaluate an assigned paper prior to class. During class, students should be prepared to identify what they thought were the major strengths and weaknesses of the paper and to defend their decisions. Further, particularly in the case of identified weaknesses, students should be prepared to discuss potential solutions and alternate experimental approaches.

As a prelude for some discussions, students might be asked to prepare a written critique of an assigned paper prior to class. Depending upon the particular circumstance, written assignments will be completed individually or as a group.

Student Presentations – Each student presents and leads an informal discussion of at least one paper selected from the recent scientific literature and in which he/she has a specific interest. The student is expected to begin by providing a framework – rationale and appropriate background – for the studies detailed in the paper from which others in attendance can follow and participate in the subsequent discussion. The student is also expected to establish the importance of the studies by identifying the problem being addressed and defining a working hypothesis. During the ensuing presentation, the student should describe and comment on the appropriateness and limitations of the general experimental design as well as individual experiments for testing the stated hypothesis, interpret results and draw conclusions. Students should demonstrate an effort to critique, rather than merely present, the paper by noting strengths and weaknesses in experimental design and data analysis, indicating where and why they agree or disagree with the authors, and suggesting alternative or additional experimental approaches that would address the problem further.

When leading the discussion, students should be prepared to answer questions relevant to the paper and to defend their interpretation and conclusions. Although they will not be expected to defend the content, they should be prepared to defend their selection of the paper.

In sessions in which they are not presenting, students are expected to actively participate in discussion. They are expected to read and critically evaluate the selected paper in advance of class and be prepared to ask questions, make comments or voice an opinion on issues that arise during the presentation. In that regard, all students are responsible for the paper being presented. Faculty are present to answer questions and redirect the discussion, if needed. Faculty will also ask questions or will make comments if clarification is needed or an important point has been overlooked.

At the end of each session, faculty and students in attendance rate the presenter's performance; a summary of those evaluations is subsequently prepared and returned to the student. Faculty also meet privately with each student immediately afterward to review the strengths and weaknesses of the presentation. Evaluation by both faculty and students is meant to be a constructive exercise and to provide a base for improvement of presentation style, control of a discussion, and critical evaluation of a paper.

Course Objectives: Upon completion of this course, students will be able to:

(1) informally present the content of a scientific paper.

(2) given a scientific paper, state the primary problem (hypothesis) and objectives of the studies from the information provided in the introduction.

(3) appraise the relative merit of scientific data within a scientific paper on the basis of general experimental design, data presentation and data analysis, regardless of the specific topic, in relation to the stated hypothesis and aims.

(4) formulate a critical question concerning design of experiments, analysis of data, and interpretation of results.

(5) rate a speaker's overall effectiveness in the presentation of a scientific paper. In so doing, a student should be able to identify deficiencies in the speakers abilities to clearly explain and critique the studies therein. [Student evaluation is performed using the form 'STUDENT PEER EVALUATION: Recent Advances: Evaluation and Presentation of a Scientific Paper'.]

Grading Policy and Rubric.

Grades are determined on the basis of both a student's presentation (20%) and participation (80%). Participation, in turn, will be dependent upon completion of written assignments outside class and contributions to in-class discussions; the percentage that each contributes to '*Participation*' will be commensurate with the relative numbers of each venue.

Student performance for both oral and written critiques of a scientific paper will be assessed by participating faculty using the evaluation template entitled 'Evaluation of a Student's Critique of a Scientific Paper', and the average score from all faculty evaluations is used to determine whether a student passes using the defined criteria. For exercises completed as a group, all members of the group will receive the same grade.
Since it is expected that students will use peer and faculty feedback to improve performance, the score obtained on a student's last presentation will be used for grading.

Participation in discussion by students who are not responsible for presentation of the paper is tracked for each session and compiled throughout the course. It is expected that comments and questions asked by students reflect their own assessment of the studies and not the fact that they did not prepare; credit is given for the former, not the latter. There is a direct relationship between the percentage of sessions in which a student actively participates and a student's grade for participation (e.g., participation in 80% of the sessions in which a student is not presenting = 80% for participation). ***Please note that attendance does not equate to participation.***

Grades are calculated as follows:

(% score for presentation)(0.2) + (% score for participation)(0.8) = overall grade (%)

Course Policies:

Attendance: Students are expected to be in class and, in fact, must actively participate to obtain a passing grade. A student can not participate if he/she is not present. An excused absence will be granted under extenuating circumstances with prior notification or after the fact with an appropriate excuse from a physician, the student's Department Chair or Graduate Program Director.

Course Communication: Announcements and other information related to the operations of this course will be relayed in class or through *Outlook* (e-mail).

Identification and Distribution of Papers: The sequence of student presentations will be determined on the first day of class. Each student is responsible for choosing a paper of his/her choice from the current literature. The paper may be on any area of pharmacology or any other discipline scientific discipline of interest to the student, but should have been published in a peer-reviewed journal within the last 2-3 years. Reviews and papers in journals such as Science or Nature are generally <u>not</u> appropriate.

Students may submit their paper to a participating faculty member for approval, but they are not obligated to do so. In any event, faculty approval does not imply a 'good' paper. Students should still be prepared to defend their selection and recognize is relative strengths and weaknesses. Students should select their papers early enough to allow for preparation and access by other members of the class. It is recommended that papers be distributed at least one week in advance of the presentation. Students are encouraged to take advantage of all available resources – including faculty – as they prepare for their presentation and to fully understand the concepts within the paper.

Presentations: Students will give a minimum of 1 presentation, with the possibility of more as time permits. Class size will, in part, determine the frequency and number of presentations required of each student. Class rank will also be a determinant, with more junior students being given more opportunities to practice presentations than more senior students. Concomitantly, expectations concerning selection, critical analyses of papers and participation will be higher for more senior students.

Students are encouraged to give informal presentations and are, in fact, discouraged from using Powerpoint or other presentation software. Although there is no set format, you will likely be most comfortable following the general format of the paper. Generally, presentations will begin with an <u>introduction</u> in which any relevant background information, the rationale for the studies, the specific purpose of the work, the authors' working hypothesis (at least to the extent you can surmise) is related so that all in the audience is on a common footing to discuss the content of the paper.

<u>Methods</u> should be discussed briefly; a detailed description of assays and other procedures in not needed unless there are nuances to a particular method that are critical to interpretation of the data. An overview of the experimental approach and general explanation of experimental design in relation what parameters were measured and why those measurements are important to addressing the purpose of the paper will suffice in most instances. Any limitations inherent to the methods should also be noted.

The remainder of the presentation should consist of a discussion of the results and conclusions. Students are expected to give a critical evaluation of the paper, addressing questions such as the following. Are the experiments designed to answer the questions asked at the outset of the studies? Do the data support the authors’ conclusion? Are the statistics appropriate? What else might have been done? How else might the authors have approached the studies? Are alternative methods more precise or definitive? Are there questions that the authors failed to address? Do I agree with the authors' conclusion - why or why not?

Students who are not responsible for presentation are expected to read the paper in advance and come to class prepared to join in discussion.

University Policies:

Students with disabilities (ADA) statement   Refer to UMC policy
Academic honesty statement   Refer to UMC policy

Bringing up scientists in the art of critiquing research

by Barbara J. Kuyper
(from BioScience 1991. 41(4):248-249)

In addition to factual knowledge of a given discipline, scientifically literate college graduates need analytical skills to interpret, apply, and communicate the scientific information they have acquired (AAAS 1990, NAS 1989). For research scientists, analytical skills are essential in writing , critiquing, revising, and defending research proposals and articles and reviewing the research of other scientists. Critical thinking and writing are activities integral, rather than peripheral, to scientific research. As Sidney Perkowitz (1989) of Emory University writes, “I have learned that when I write a research paper I do far more than summarize conclusions already neatly stored in my mind. Rather, the writing process is where I carry out the final comprehension, analysis, and synthesis of my results” (p. 353).

But graduate students rarely receive formal training in thinking or writing about research. Many become good scientists who are nonetheless severely handicapped in communicating their own research and in eliciting useful assessments of it from others. With a good analytical mind and a few other tools at hand, however, a scientist at any career stage can learn the art of critiquing research.

Critical assessment of research articles

Traditionally, the scientific method involves formulating a hypothesis, designing an experiment to test the hypothesis, collecting data, and interpreting the data. The structure of research articles (called IMRAD) parallels this sequence: introduction, including statement of objective; methods; results; and discussion. The model for conducting research and the structure for presenting it have variations, but the basic analogy remains. Research is conducted and presented by the scientific method, and it can also be analyzed by using the same logical sequence of steps.

Critical assessment of a research article appropriately occurs at several stages. The author critiques the first draft and revises it accordingly. Friendly colleagues review the revised draft, and the author revises the manuscript again in the light of their suggestions. These pre-submission critiques and revisions are intended to improve the written presentation of research, short-circuit unfavorable reviews, and decrease time to publication. On submission, the article undergoes peer review to determine acceptability for publication. when an article enters the scientific literature, it becomes open to scrutiny by other scientists, as well as by journalists, politicians, and the general public, and at this stage a scientist’s reputation can be firmly established or irrevocably damaged.

The value of being able to self-critique manuscripts and to have confidence in the critique cannot be overemphasized. A scientist should ask, “What was my bias in carrying out procedures or in collecting data? Did I want my results to happen?” Scientists are human and thus subjective, and awareness of one’s own subjectivity is essential in preparing objective research results for presentation to the scientific community (Harper 1990).

For the same reason, scientists need to learn how to elicit useful critiques from colleagues. “Is my bias showing? Can you tell what I’m most afraid of? Can you detect any weaknesses in my experimental design or methodology that an incisive reader will most certainly expose if you don’t? As a friendly colleague, I’d like you to tell me before a journalist tells the world!”

Developing skills in critiquing research

Some tools are needed for training scientists to critique their own and their colleagues' research articles. An analytical mind-set is basic to all facets of scientific research, including critical analysis of the scientific literature. In editing manuscripts for research scientists, I prepare a written summary that assesses the article section by section. This editorial critique is designed to give the author an overview of the manuscript rather than getting bogged down in editorial clean-up work or a sentence-by-sentence analysis. A colleague's written critique also provides an overview, but it emphasizes design and interpretation of research rather than presentation. The checklist, a traditional editors' tool, is also useful in scrutinizing scientific manuscripts from authors', statisticians', and reviewers' standpoints (Applewhite 1979, CBE Style Manual Committee 1983, Gardner et al. 1986, Squires 1990).

I have developed a checklist for critiquing a research article at an early draft stage that both the author and in-house reviewers can use (see box). The checklist focuses on structure, or organization, and its interrelationship with content. It is based on the IMRAD structure but can be modified for other types of journal articles. In assessing articles with the aid of the checklist, fluorescent color markers are useful tools that give authors and reviewers something useful (and playful) to do. I use a yellow marker to call attention to statements of objectives at various points in the manuscript (and discrepancies among them) and a rose marker to identify undefined or misused terms.

A critique of the introduction alone (steps 1-4) sometimes unravels the entire article. Discrepancies between the title of the article and the stated objective at the end of the introduction throb in the fluorescent color. The researcher may discover an ambiguity in thinking about the purpose of the research that was previously concealed but is now glaringly obvious.

A careful scrutiny of research methods (steps 5-8) may expose fatal flaws in sample selection or experimental design that invalidate the results. This disturbing revelation can be beneficial over the long run, however, if it helps the scientist to cut losses and move on to better-defined research. A review of methods on completion of a research project can also emphasize the importance of choosing an appropriate experimental design at the onset and evaluating the research project as it develops.

The results, particularly as presented in tables and illustrations, almost inevitably require drastic redesign and revision. Selecting, aligning, and labeling data appropriately in tables require as much thought as does the textual description of results. Ideally, the author has designed the tables before writing the results section, and steps 9-12 on the checklist directs reviewers to examine the tables first. A table should be self-explanatory, with a title that accurately and concisely describes content and column headings that accurately describe information in the cells. Instructions for preparing scientific tables (CBE Style Manual Committee 1983) and illustrations (CBE Scientific Illustration Committee 1988) are invaluable tools in writing and revising research articles.

Authors often seem mentally fatigued by the time they have defined in writing what their research was really about, struggled with statistical analysis of data, sorted out meaningful results, and revised tables again and again. Consequently, the discussion often degenerates into a feeble rewording of results rather than interpretation of the research and its status in relation to other studies in the field. In critiquing the discussion section (steps 13-16), the author can easily detect mere repetition of results. To validate and refine interpretation, however, a colleague's probing questions are probably more fruitful at this stage than is self-examination.

The overview section of the checklist (steps 17-20) requires the author or reviewer to step back and reconsider the manuscript as a whole. Does the author think and write logically? Is the organizational sequence of the paper logical and appropriate to content? Are the objectives and results of the research stated clearly? Does the article fit the stated purpose of the journal to which it is being submitted?

Conclusions

After all is said and done, critiquing research is intellectual fun. The ability to scrutinize a piece of writing with a critical eye requires time for leisurely contemplation, an analytical mind (the scientific mind?), a zest for arguing with colleagues, and the ability to set ego aside. If we do not assess our own research, journal reviewers and subsequent readers will do it for us, with the potential for much more badly bruised egos and scientific reputations.

Acknowledgments
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Checklist for critiquing a research article

Title:
Author:
Introduction

1. Read the statement of purpose at the end of the introduction. What was the objective of the study?
2. Consider the title. Does it precisely state the subject of the paper?
3. Read the statement of purpose in the abstract. Does it match that in the introduction?
4. Check the sequence of statements in the introduction. Does all information lead directly to the purpose of the study?

Methods

5. Review all methods in relation to the objective of the study. Are the methods valid for studying this problem?
6. Check the methods for essential information. Could the study be duplicated from the information given?
7. Review the methods for possible fatal flaws. Is the sample selection adequate? Is the experimental design appropriate?
8. Check the sequence of statements in the methods. Does all information belong in the methods? Can the methods be subdivided for greater clarity?

Results

9. Scrutinize the data, as presented in tables and illustrations. Does the title or legend accurately describe content? Are column headings and labels accurate? Are the data organized for ready comparison and interpretation?
10. Review the results as presented in the text while referring to data in the tables and illustrations. Does the text complement, and not simply repeat, data? Are there discrepancies in results between text and tables?
11. Check all calculations and presentation of data.
12. Review the results in the light of the stated objective. Does the study reveal what the researcher intended?

Discussion

13. Check the interpretation against the results. Does the discussion merely repeat the results? Does the interpretation arise logically from the data, or is too far-fetched? Have shortcomings of the research been addressed?
14. Compare the interpretation to related studies cited in the article. Is the interpretation at odds or in line with other researchers' thinking?
15. Consider the published research on this topic. Have all key studies been considered?
16. Reflect on directions for future research. Has the author suggested further work?

Overview

17. Consider the journal for which the article is intended. Are the topic and format appropriate for that journal?
18. Reread the abstract. Does it accurately summarize the article?
19. Check the structure of the article (first headings and then paragraphing). Is all material organized under the appropriate heading? Are sections subdivided logically into subsections or paragraphs?
20. Reflect on the author's thinking and writing style. Does the author present this research logically and clearly?

__Explicit Authorship by Carlos Galindo-Leal (from Bull. Ecol. Soc. Amer. 1996. 77(4): 216-220)

fiu.edu; collins

HOW TO READ A SCIENTIFIC ARTICLE

> "Probably what you should learn if you are a graduate student is not a large number of facts, especially if they are in books, but what the important problems are, and to sense which experiments, work that has been done, probably aren't quite right."
> James Watson, of Watson & Crick (DNA fame)

When students in the sciences are first faced with using the primary research literature, the prospect sometimes seems overwhelming. Finding pertinent journal articles often seems to involve a maze of abstracting journals, indifferent librarians, missing volumes, CDroms from hell, and bound periodicals that refuse to flatten themselves for photocopiers (no matter how hard you press on them, CPR-style). Even once an article has been located--or, in the case of this class, provided--there is the problem of reading it. The *worst way* to assimilate a research paper is to read it word for word, title to literature cited, as if it were a textbook. This approach is a waste of time, because perhaps as few as 1 in 4 articles that find there way into your hands should be committed to your brain, and is deadly boring.

Before reading one word of an article, ask yourself: What am I looking for in this article? Knowing what I do about the subject, what gaps need to be filled, what knowledge needs to be expanded, and what controversial points need to be corroborated? Generate expectations of a journal article before you read it. This will help your analysis of the work in front of you, plus keep you more interested in the material. Then what:

1. Read the authors' names. Where and with whom are they working? What is their expertise? Names may mean little at first, but as you "wade through" a scientific subject or topic you will find familiar names cropping up, and you will develop those with whom you agree and those whom you question.
2. Read and digest the title. It should summarize the work of the article well, help you to clarify your expectations of the paper, and it should be an attention-getter (if you are reading the article, it has probably already accomplished that task!).
3. Read the abstract carefully and try to understand it (though it may be the densest prose you will ever encounter). Abstracts are as difficult to read as they are to write, because an entire publication must be summarized in an understandable way in only about 200 words. By now, you should have a good idea of what the paper is about and what you have gotten yourself into. At this point, it may be obvious that the paper does not answer your questions. If this is true, move on, but be conservative because the authors' interpretation of the research presented in the abstract may not be the same as yours after reading the full paper. **Never** cite an article after having read only the abstract!
4. Picture time--flip through the article and study the figures, illustrations, and tables, including the legends. It will probably become necessary to consult the Methods and Results section to clarify figures and understand the experimental design. If the article is closely related to your research, closely examine the techniques described in the Methods section. There may be problems there, but more likely there will be a new, perhaps better, approach to your own research. It should be clear to you by now whether this paper will be truly helpful. If so, now it is time to be critical (please, see the note below about this word).
5. Read the Introduction and be sure the author knows the field, has adequately researched past work, and understands where their work "fits into the puzzle". Generally, the Intro and Literature Cited sections go hand-in-hand. Most importantly, within the first paragraph or 2 of the Introduction the

authors should have made it very clear what their objectives for the research were, and what their paper will tell you.

6. Check to see if the Results adequately and accurately describe the data presented in the paper. Are there additional points that should have been brought up? Is there something in the figures or tables that does not substantiate the authors' claims that was not mentioned? Do the figures and tables clearly, succinctly, and attractively present the results of the paper? Remember that great data presented clumsily or sloppily will not be seen as great, only clumsy or sloppy.
7. Now read the Discussion. This is perhaps the most important section, because it is here that the results (the "what" of the research) are explained. That is, here is where the authors should [at least try to] explain "why" they saw what they saw. Beware of unsubstantiated speculation, though do not fault, off-hand, the presentation of hypotheses for future work or even expectations of findings from those future experiments. On the other hand, there are authors who are prone to timidity, understatement, or who are just plain invertebrate about their ideas. You should not be left guessing, or left to fumble to your own conclusions because an author was unwilling to take even a small step out onto a limb. As a moderate example of such understated conclusions, Watson and Crick ended their historic presentation of the structure of DNA with the sentence: "It has not escaped our notice that the specific pairing we have postulated immediately suggests a possible copying mechanism for the genetic material." In fact, the complimentary base pairing they presented was no less that a quantum leap in our understanding of biological systems, in terms of both modern biochemistry and evolution!

Bear in mind that the ultimate burden of assessing published material lies with you, the reader. Take the time and energy to do this and you will gain more and be further along that the person who depends on the author for interpretation. Having just completed a critical reading and assimilation of a journal article pertinent to your work, you should be able to paraphrase the significance of this paper with 3 or 4 sentences free of technical jargon. You should also be able to both praise and criticize several points of the paper (*this is important--see note below*). A general rule of thumb, regarding what goes where, when both reading and writing a scientific article is:

Title: Short, succinct, eye-catching, all-encompassing

Abstract: Summary of Methods, Results, and Discussion starting off with a statement of **why** the research was done and with emphasis on **why** the results are significant.

Introduction: **When** was past work done, by **whom**, **why** was their work important, **what** you plan to do in your paper, and **why** what you did is important.

Materials and Methods: **How** you did what you did and **where** you did it--nothing more.

Results: **What** the data show you--nothing more.

Discussion: **Why** the data show what they show, and **how** your analysis relates back to your objectives from the Introduction.

Note: Some journals will allow the Results and Discussion sections to be combined. In this case, the data should be divided up into logical groups, and for each group (generally separated by a subheading) the **What** and the **why** are presented together.

<u>A note on critiques:</u> A critique "considers the merits and demerits of something and judges accordingly" (Webster). When critiquing an article (or anything, really), remember that there are positive points to be found, and made, about everything. To present only negative criticism is wrong. Never forget to acknowledge that, while we all make mistakes and do things incorrectly, we also all do things correctly sometimes. A pat on the back can go a long way.

STUDENT PEER EVALUATION
Recent Advances: Evaluation and Presentation of a Scientific Paper

Presenter: ______________________ **Date:** ______________

Scientific Presentation

Introduction (5%)

- Stated the author(s) and title or defined the overall topic of the paper ☐
- Stated the overall purpose of the paper ☐
- Provided sufficient background to orient the audience to the theme of the paper ☐
- Identified the specific data gap that the paper addresses (even if authors did not) ☐
- Identified the specific problem or question being addressed (even if authors did not) ☐
- Provided more than what was given by the author(s) ☐

Methods (5%)

- Rationale for general experimental approach was provided ☐
- Rationale for specific experiments was stated; their relationship to the problem or question was apparent ☐
- Detail was sufficient (but not excessive) for understanding methods and interpreting results ☐

Results (5%)

- Explained figures and tables in a manner that aided interpretation (you knew what was measured) ☐
- Explained relationships between experiments (it was clear how results of one lead to the next) ☐
- Related results back to the original problem or question ☐

Critique (80%)

- Commented on appropriateness (on inappropriateness) of experimental design ☐
- Noted limits of design and/or analytical methods ☐
- Suggested alternate experimental approaches ☐
- Noted appropriateness of statistical analyses ☐
- Noted limits to interpretation of results ☐
- Offered own interpretation of data rather than a mere description or a restatement of author's opinion ☐
- Noted additional or unanswered questions ☐
- Agreed (or not) with the authors conclusions, and indicated why. ☐

General Knowledge, Demeanor and Effectiveness (5%)

- Had paper available in advance ☐
- Engaged you in discussion and held your interest ☐
- Explained unique jargon and abbreviations ☐
- Knew the details of the paper and supporting material sufficiently to be able to explain what was done ☐
- Was knowledgeable of supporting and introductory material ☐
- Was able to answer questions ☐

Evaluation of a Student's Critique of a Scientific Paper

Student: ____________________ Evaluator: ____________________ Date: __________

Please indicate the rank of the student and the course, if applicable.

- [ ] 1st year
- [ ] 2nd year
- [ ] 3rd year
- [ ] Journal Club
- [ ] General Seminar
- [ ] Qualifying Exam

Other: ____________

Please rate the student in each of the major categories based on its respective criteria. A criterion is scored with a

- 0, if it is met infrequently or not at all (<25% of when applicable);
- 0.5, if it is met some of the time (25-75% of when applicable); and
- 1, if it is met most of the time (>75% of when applicable).

Then, criterion scores are summed to obtain a score for each category. The total score for each category should accurately reflect your perception of the student's performance. The relationship between the two should be roughly:

- 5, outstanding (A^+).
- 4, very good (B^+ to A).
- 3, adequate/good (B^- to B).
- 2, poor (D to C).
- 1, inadequate (F).

A mean score for all categories ≥3, with a score ≤2 on no more than one category, is passing.

	Criterion	Summary Score
General Knowledge and Effectiveness		
The student		
was knowledgeable of introductory and other supporting material.		
was clear and concise; explained unique jargon and abbreviations.		
knew the details of the paper and supporting material sufficiently to explain what was done.		
was able to speculate as to why a particular design or method might have been used.		
generally presented in a manner that enhanced your understanding of the results.		
Scientific Presentation		
Introduction		
The student		
identified the author(s) and source of the paper (citation, peer-reviewed, rapid communication).		
identified the overall topic or purpose of the paper.		
identified the specific data gap being addressed (even if authors did not).		
identified specific problems or questions being addressed (even if authors did not).		
provided a background that adequately oriented you to the theme of the paper.		
Methods		
The student discussed the		
rationale for the general experimental approach or approaches.		
rationale for specific experiments.		
relationships between experiments and the stated problem or question being addressed.		
methods in sufficient detail to understand what was measured.		
methods in sufficient detail to understand how specific measurements were made.		
Results		
The student		
identified the question addressed by individual experiments or sets of experiments.		
explained data (figures and tables) in a manner that aided interpretation of results.		
offered tentative conclusions on the basis of data obtained.		
discussed the relationships (logic) between individual experiments.		
discussed the relationship of results to the original problem(s) or question(s).		
Critique of Experimental Design and Methods		
The student		
discussed the appropriateness of experimental design.		
discussed the validity of statistical analyses.		
noted limits of design and/or analytical methods.		
suggested alternate experimental approaches or experiments.		
noted additional experiments that might further address the original problem or question.		
Critique of Results and Interpretation		
The student		
compared data obtained with data anticipated.		
discussed the validity of authors' interpretation; offered alternate interpretation where justified.		
discussed the validity of authors' overall conclusions; offered alternate conclusion where justified.		
discussed effectiveness of the study at addressing the original knowledge gap or question.		
noted additional results that might substantiate or refute the authors' or own interpretation/conclusion.		

Please provide any written comments on the back of this sheet.

Average score for all categories: ____